Advanced Algorithms for Three Dimensional Visualization of Geospatial Data

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Submitted By

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Introduction

Three-dimensional (3D) GIS is a vast topic that encompasses a wide range of disciplines, including computer, cartography, surveying and mapping, urban construction, power, transportation and many other areas all demand 3D GIS visualization technologies. Further optimization and development of the technology has become highly necessary in order to improve the visualization technology of 3D GIS and give better and more convenient human being services.

The modelling of a three-dimensional geographic information system is more sophisticated than that of a two-dimensional geographic information system since it incorporates a variety of modern technologies, but the benefits are evident. Currently, large-scale modelling is challenging, existing data processing algorithms are unrealistic, and the 3D presentation effect is poor. As a result, large-scale data processing and modelling must be carried out based on the current map database and data from multiple 2D geographic information systems. Simultaneously, enhance the rendering performance and optimize the visualization technologies for 3D GIS. Furthermore, the rendering effect has emerged as a prominent topic in the field [1].

The terrain can be visualized in two ways: two-dimensionally and three-dimensionally. The two-dimensional technique uses two-dimensional maps such as contour maps, layered maps, and so on to represent three-dimensional topography. This is the customary way of doing things. With the advancement of computer graphics and power in recent years, traditional 2D map expression has steadily given way to 3D representation. Three-dimensional maps, as opposed to two-dimensional maps, give visitors a more realistic and vivid experience [2].

In topographic expression and GIS applications, the digital elevation model (DEM) based on a three-dimensional surface model is the most extensively employed. DEM is a data or image with X, Y, and Z coordinates that is used to digitally depict terrain. Several processes, such as visualization, enhancement, and manipulation, can be used to obtain valuable information from this data or image. DEM is mostly used to prepare 3D visualization maps such as Elevation Map, Slope map, Aspect Map, Contour maps, watershed map and many other several 3D maps [3].

The development of many various applications for the construction of 3D maps and Visualizations has recently been made possible thanks to precise terrain modelling and mapping. Multi-perspective views for interactive visualizations and 3D panoramic maps are examples of

advanced techniques used in landscape visualizations. 3D maps are ideal for tourist applications, scientific presentations, regional planning, and management because they provide a better perception and comprehension of landscape spatial linkages.

Aspect maps, Hillshed maps, and other 3D visualisation approaches are demonstrated in this study, and their practical deployment in a real-world context is also demonstrated in this study. This article also includes a 3D elevation map of India, as well as elevation information for each site on the map. A wide range of applications, including urban planning, geology study, hazard monitoring, natural resource research, and agricultural management, can benefit from the use of these maps. Inherent in any mapping project from the Data Collection phase is the provision of 3D geographic data, which is a time-consuming, cost-effective, and labor-intensive procedure. The availability of tools that evolve around real or virtual world data is going beyond this level, thanks to the advancement of software development and the availability of appropriate application-oriented software. In order for this tool to be effective, it must be capable of both analysis and visualisation. Spatial Data describes how the two disciplines mentioned above, namely data and application, can work together to create an environment for 3D GIS and, as a result, a spatially enabled society.

Problems Statement:

It's difficult to visualize geospatial data integrated in a three-dimensional terrain. When uncertainty information must also be supplied, the problem becomes considerably more complicated. This research looks at how to graphically represent all three parts of the landscape: 3D topography, geospatial data, and data-related uncertainty. We contend that depicting all components in great detail will almost certainly exceed the visual budget. As a result, we propose a visualization technique that prioritizes one feature while portraying the remaining two in minute detail. We examine numerous design possibilities that allow us to create visual representations with varying priorities. In the area of avionics applications, our technique has been deployed as a tool for rapid visualization prototyping. For a use scenario including the viewing of 3D topography and unpredictable weather data, practical solutions are provided.

Objective of the work:

The main objective of the study area is to show 3D algorithms used for Visualization of geospatial data. To achieve this objective, the following specific objectives have been defined:

1. To Study practical aspect of Algorithms used in 3D Modeling and Visualization of Digital elevation models
2. Analyze the status of existing System and models for integrated geo-spatial data with a reference to terrain modelling and 3D geographical information system
3. The main objective is also to show the 3D GIS Visualization application in real world.
4. To prepare 3D Visualization of Slope map, Aspect Map and Hillshed Map with their application in the real world.
5. To prepare 3D Visualization model for watershed management study.
6. Create and display the 3D Visualization application in Tsunami modeling using the geospatial technology.
7. To show the change detection of pre and post 3D visualization of flood hazard modelling using the available open source data.

Literature Review

The problem of data structuring and modelling for 3D data in an analytical GIS environment remains unsolved as a result of the previous debates. The only near-solutions available focus on the visualization aspect. This functionality gap in GIS needs to be looked. The objective of this research is on geospatial data organization and data modelling, with a particular emphasis on building software that will aid in the modeling of 3D GIS. To do this, a number of relevant data structures that can handle both 2D and 3D data are studied. This endeavor is realized through software development, which includes data organization, applicable algorithm creation and object-oriented data modelling.

A 3D GIS must be built to meet numerous needs from the earth scientific community, including integrating all relevant elements into a 3D geographic model and providing efficient functions for creating and using the 3D spatial model. A 3D spatial model can be created using the tools offered by a 3D GIS to allow the virtual performance of numerous operations that would otherwise be impossible, expensive, or destructive to carry out in reality. To make the results gained from operations on the model equivalent to actual operations in reality, a high-quality 3D

spatial model that accurately reflects all relevant parts of reality—that is, real-world objects of interest and the relationships between them—is required. The complexity of the geographical model determines the number of operations available, which indicate the system's functionality. Many GIS operations nowadays are created by merging several geographical models and related functions, such as those for modelling terrain relief and 2D terrain characteristics, with thematic aspects (for example, Colour, ownership, price). The digital terrain model (DTM) component is used in conjunction with standard GIS applications to achieve this result. The method entails a spatial model with components that are nevertheless stored independently and only loosely linked. As a result, the model isn't very reliable and may not accurately reflect real-world conditions.

Virtual 3d mapping and analysis with data and images from remote sensing

According to [4] C. Metral: This research shows that utilizing high-resolution data, pictures, and sketchup tools, realistic 3D building models can be created and visualized. The procedure's utility for 3D cadastral development was assessed. Line of sight analysis and security camera coverage were enabled using urban 3D models and DEM. For local governments, 3D information can be a valuable resource for urban planning, disaster relief, and utility services.

The investigation of a 3D GIS modelling technique based on digital photogrammetry.

Zhou Li (2008): With the rapid development of 3D GIS applications, the flaws in 2D GIS, such as lack of intuitive sentiments, difficulty managing space objects, and uncertainty in expressing information, are becoming increasingly apparent [5]. The geographical environment can be recovered using 3D GIS. Every point in 3D models has its correct coordinates, allowing them to portray landscape elements in a natural way and perform 3D visualization management and analysis. Because 3D modelling currently constructs each structure as a separate entity and manages each entity-oriented database, it is unable to resolve effectively the object-oriented classification to achieve spatial data management and analysis, limiting the functionality of 3D GIS applications. This study offers an object-oriented 3D modelling technique for secondary development using an existing digital photogrammetry software platform. The text covers the following topics: the object-oriented concept of 3D modelling; 3D GIS modelling technology based on digital photogrammetry; Digital Campus examples of 3D modelling over current Digital Campus space modelling, using the methods of divide entities and management-oriented

data modelling to combine the 3D model of the campus and database management objectives, and achieve the 3D model of the campus on the school's Information Management Services. The accurate information in a digital and inquiry-friendly format.

Research and development of 3D modelling visualizations algorithms

According to Chen Qiuhong: A novel graphical 3D modelling Visualizations approach is proposed in this study, based on in-depth analysis of existing 3D modelling algorithms. This technique can build 3D models with higher precision using less photos, resulting in a significant increase in the efficiency of 3D modelling realization. Furthermore, this approach is straightforward to implement and use, and hence has a high practical utility [6].

Material, Methodology and Algorithms

Material Used:

3D Modeling from SRTM Data

The Shuttle Radar Topography Mission (SRTM)- DEM data with 30m resolution (Figure-9) was downloaded and used for study purposed from http://edc.usgs.gov.[7].

SRTM (Fig-1) acquired elevation data on a nearly worldwide scale. SRTM was a specially modified radar system that flew on the Space Shuttle Endeavor in February 2000 for an 11-day mission. The National Geospatial Intelligence Agency (NGA) and the National Aeronautical Administration and Space Administration (NASA) are leading an international effort called SRTM (NASA).

During the 11-day mission, Endeavor orbited Earth 16 times per day and completed 176 orbits. With data points presented every 1 arc glob second, SRTM has successfully collected radar data between 60° north and 56° south latitudes on more than 80% of the earth's land surface [8].

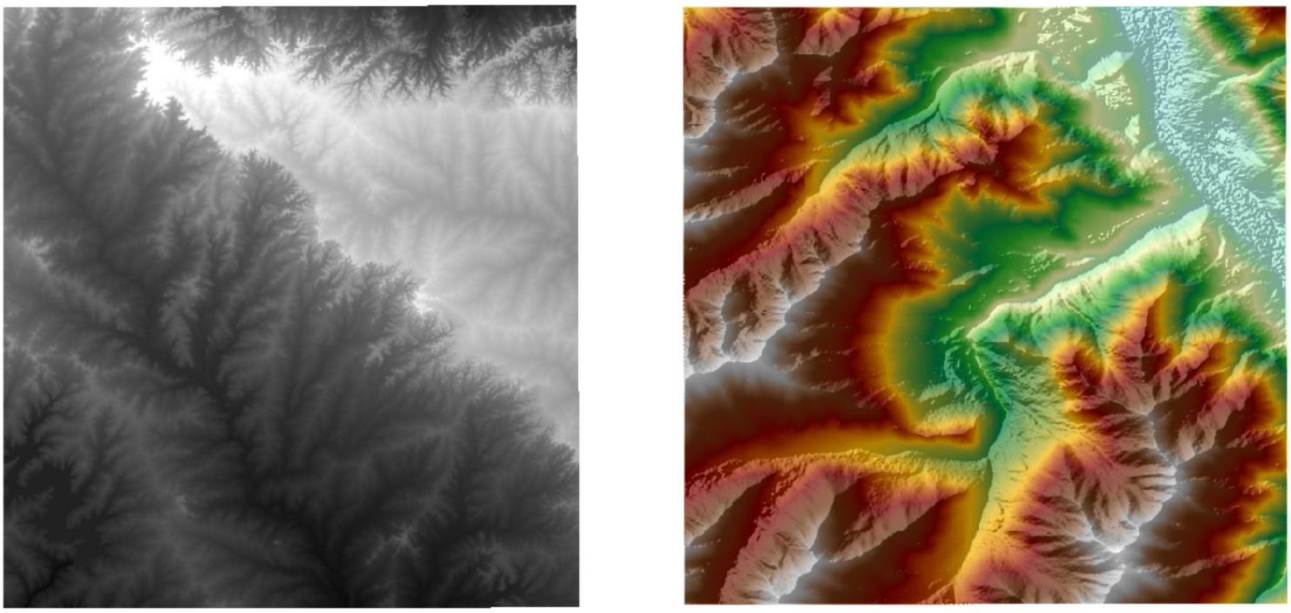

Fig. 1 SRTM DEM Raw image in the left and 3D View in right after processing in GIS software, having spatial resolution of 30m.

3D Modelling of Digital Elevation Model (DEM)

Slope and Algorithms

The Slope tool calculates the maximum rate of change in value from that cell to its neighbors. Basically, the maximum change in elevation over the distance between the cell and its eight neighbors identifies the steepest downhill descent from the cell [9].

The rates of change (delta) of the surface in the horizontal (dz/dx) and vertical (dz/dy) directions from the center cell determine the slope. The basic algorithm used to calculate the slope is:

$$slope_radians = ATAN\ (\ \sqrt{}\ ([dz/dx]^2 + [dz/dy]^2)\ )$$

Slope is commonly measured in units of degrees, which uses the algorithm:

$$slope_degrees = ATAN\ (\ \sqrt{}\ ([dz/dx]^2 + [dz/dy]^2)\ )\ *\ 57.29578$$

The slope algorithm can also be interpreted as:

$$slope_degrees = ATAN\ (rise_run)\ *\ 57.29578$$

where:

$$rise_run = \sqrt{}\ ([dz/dx]^2 + [dz/dy]^2]$$

Aspect Algorithm

Aspect is used to identify the downslope direction of the highest rate of change in value from one cell to its neighbours. Slope direction is another term for it. The values of each pixel in the output raster correspond to the compass direction that the surface faces at that location. From 0 (north) to 360 (south), it takes 360 degrees to complete a full circle (north). Flat land with no downslope direction receives a -1 grade. In an aspect dataset, the value of each cell specifies which way the cell's slope is facing (Figure-2).

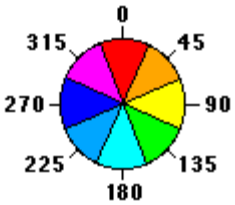

Fig.2 Aspect Direction

A moving 3 x 3 window visits each cell in the input raster, and for each cell in the center of the window, an aspect value is calculated using an algorithm that incorporates the values of the cell's eight neighbors. The cells are identified as letters a to i, with e representing the cell for which the aspect is being calculated.

The following algorithm is used to calculate cell e for the rate of change in the x direction:

$$[dz/dx] = ((c + 2f + i) - (a + 2d + g)) / 8$$

The following algorithm is used to compute cell e for the rate of change in the y direction:

$$[dz/dy] = ((g + 2h + i) - (a + 2b + c)) / 8$$

Aspect is computed by taking the rate of change in both the x and y directions for cell e and multiplying it by:

$$aspect = 57.29578 * atan2 ([dz/dy], -[dz/dx])$$

Hillshed or shaded relief Algorithm:

The Hillshade tool calculates the illumination lighting values for each cell in a grid to establish the potential lighting of a surface. It accomplishes this by locating a hypothetical light source and computing the illuminance values for each cell in relation to its neighbours. When employing transparency, it can substantially improve the visibility of a surface for analysis or graphical display reasons. shadow and light are by default in grayscale shades with integers ranging from 0 to 255. (increasing from black to white).

Hillshade algorithm

The algorithm for calculating the hillshade value is as follows:

$$Hillshade = 255.0 * ((\cos(Zenith_rad) * \cos(Slope_rad)) + (\sin(Zenith_rad) * \sin(Slope_rad) * \cos(Azimuth_rad - Aspect_rad)))$$

Note that if the calculation of the hillshade value is < 0, the output cell value will be = 0.

Methodology for Hydrologic analysis of 3D Visualization of watershed

The flowchart below (Fig-3) illustrates how to extract hydrologic data from a digital elevation model, such as watershed boundaries and stream networks (DEM) [10].

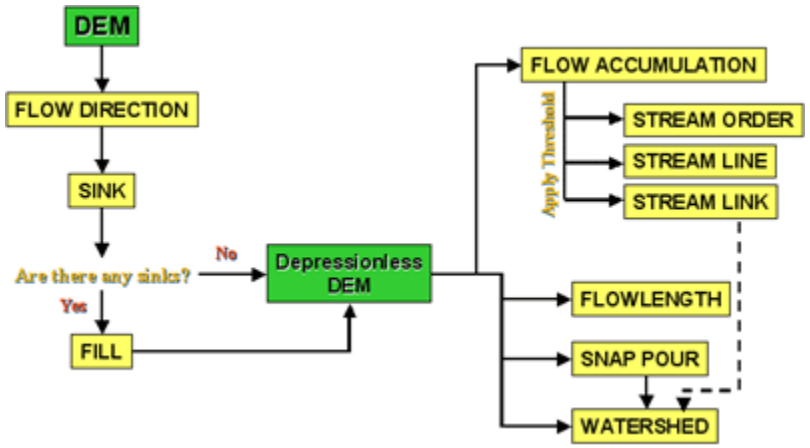

Fig.3 showing flow chart of watershed modelling

Materials and Methodology used in 3D Tsunami modeling

Bathymetric data

The term "bathymetry" was initially used to describe the depth of the ocean in relation to sea level, but it has now evolved to denote "submarine topography," or the depths and shapes of undersea terrain. We used bathymetry data in our 3D tsunami modeling.

Bathymetric maps depict the land that lies underwater in the same manner as topographic maps depict the three-dimensional features (or relief) of upland terrain. Color and contour lines known as depth contours or isobaths can be used to represent variations in sea-floor relief.

Bathymetry is the foundation of hydrography, which is the science of measuring the physical characteristics of water bodies. Hydrography encompasses not just bathymetry but also the shape and features of the shoreline, as well as the characteristics of tides, currents, and waves, as well as the physical and chemical qualities of the water.

The GEBCO 2021 Grid, GEBCO's current gridded bathymetric data collection, is a worldwide topography model for ocean and land that provides elevation data in meters on a 15 arc-second interval grid. It comes with a Type Identifier (TID) Grid that details the many sorts of source data on which the GEBCO 2021 Grid is based.

The GEBCO 2021 Grid and TID Grid can be downloaded as global files in netCDF format or as a set of 8 tiles (each with a 90° x 90° area) in Esri ASCII raster and data Geotiff formats, providing global coverage [11].

Result and Discussion

3D modelling of Slope

The greatest change in height over a given distance is known as the slope. The purpose of a slope map is to identify structural difficulties by understanding the local and regional slope variation of the terrain. On slope maps, you can see fault scarps and strata tilting. As seen in the examples below, the Slope tool is most commonly used on an elevation dataset. Slopes with a greater degree of difficulty are more difficult to navigate. The output slope raster is Colure red, while the gentle slope is Colure blue (Figure-4). The approach can also be used to find rapid changes in value in other types of continuous data, such population data.

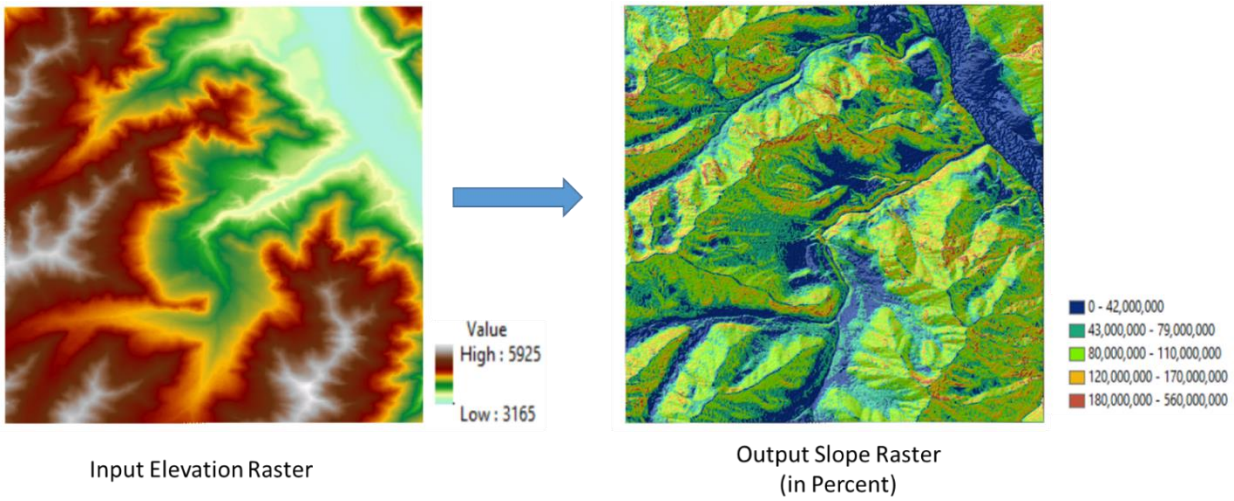

Fig.4 shows 3D modeling visualization of Slope

3D modeling application of Aspect

Aspect is measured at (0-360^{o}) degrees clockwise after being specified as the slope surface's direction. Because flat surfaces do not face any direction, they are assigned a -1 value. The duration and severity of humidity, precipitation, wind, and sun on the land are all influenced by the aspect factor. Aspect is measured in degrees and calculated using definite differences (Wilson and Gallant, 2000). The Surface Analysis module of 3D Analyst was used to detect aspect features of the research region, same as it was used to discover slope characteristics. Four cardinal directions, four intercardinal directions, and flat lands were classified into nine groups (Figure 5). The following figure shows an elevation dataset and the output aspect raster.

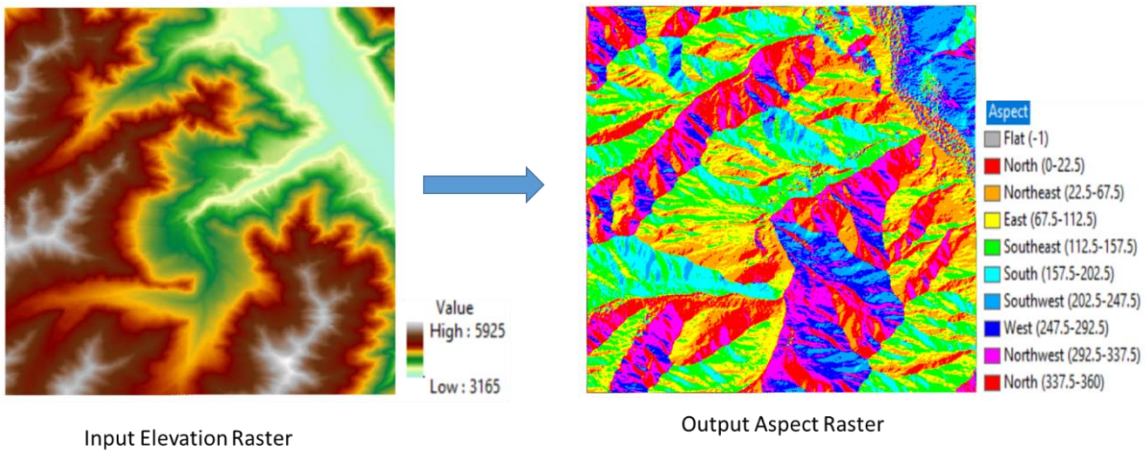

Fig.5 Showing Aspect map

Aspect Map is very useful in specialized agriculture, Microclimate, Ski-slope selection Landslide studies.

3D modelling Application of Hillshed

By stacking an elevation image on top of a Hillshade image and changing the transparency of the elevation image, you can quickly create a visually pleasing relief map of a terrain.

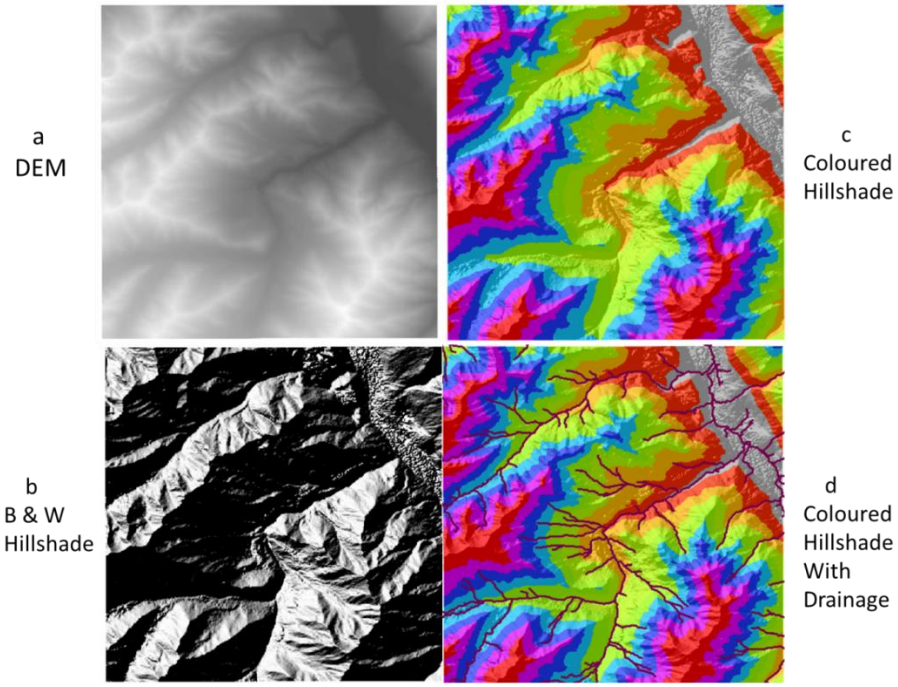

Fig.6 Showing SRTM DEM, Black and White Hillshed, Color Hillshed & Color Hillshed with Drainage

In the above Fig. 6 a represents original DEM image from that Black & White Hillshed is created (6 b), if we used Original DEM image with color pellet and 50% transpanacy on Hillshed map then beautiful 3D terrain is appears (6 c), then after adding Drainage network on Hillshed map it looks very easy understanding the drainage map (6 d).

Watershed Analysis:

The watershed profile separates the land into unequal portions with differing topographical characteristics, natural endowment, and sensitivity to natural environmental restrictions such as flooding, water logging, riverine erosion, drought, and soil erosion. The livelihoods of the local population, which is predominantly rural, are heavily reliant on natural resources as well as

restrictions. The development of the watershed/s necessitates a greater awareness of the diverse natural resources, their interrelationships, and their impact on stakeholders' livelihoods. Watershed development failure is frequently caused by misalignments with various aspects of nature, which are caused by a lack of awareness of natural resources among various watershed stakeholders. Geoscientific terrain studies, stakeholder socioeconomic assessments, and knowledge of local practices are all needed for watershed development to provide well-coordinated and synthesized information on the entire watershed area. This will also aid in the mitigation of both natural and man-made risks. The use of remote sensing data to assess natural resources such as soil, geology, drainage, and economic activity through land use and infrastructure in the watershed area is widely established. This data is also used to track the evolution of the watershed through time. For better planning, execution, and monitoring of the project, GIS is a highly strong tool for developing the watershed region with all natural and socio-economic sides.

Modeling in three dimensions Watershed analysis is utilized in natural resource management and planning.

1. To give hydrological modelling with the relevant inputs.
2. Flood prediction models and snowmelt runoff models, among other things
3. Watershed analysis not only identifies catchment boundaries, but also offers hydrological parameters that can be used in management programmes.

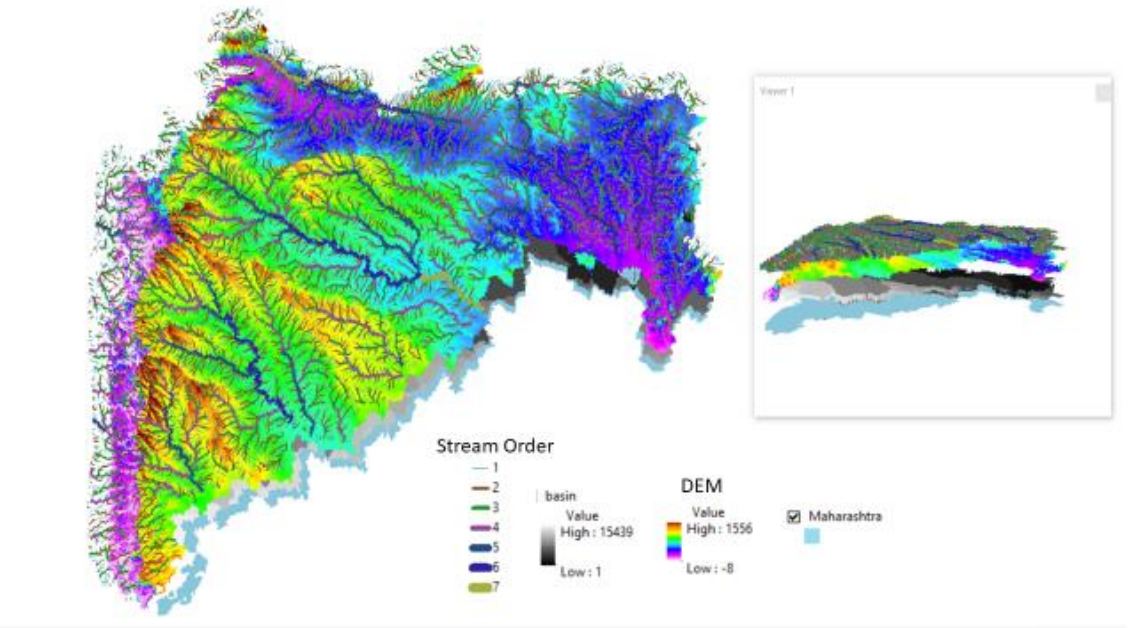

Figure-7 Showing Watershed map of Maharashtra

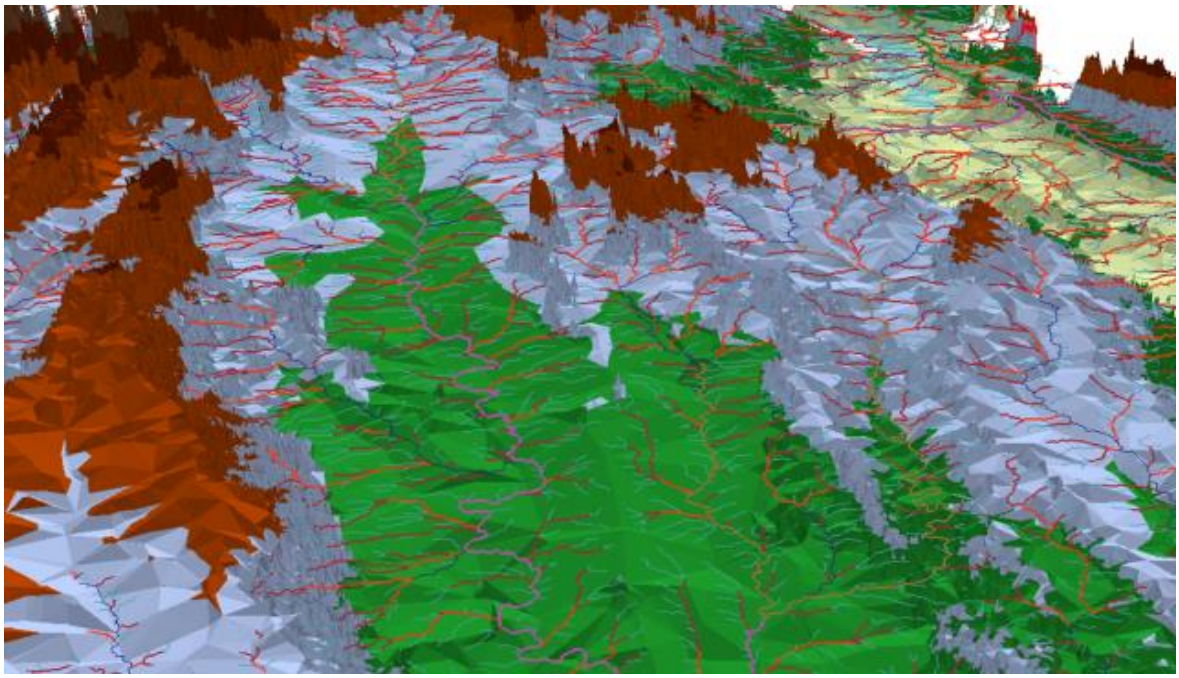

Fig-8 Showing 3D View and zoom view of above Watershed map of Maharashtra

Terrain 3D modeling

A terrain database is a digital representation of the landscape in which the simulation takes place (Figure-9). What can be done in the simulated world depends on the character, quality, and substance of the game. The size of the area where the simulation can be run is determined by the terrain's geographic coverage. The accuracy of interactions available within the environment is determined by the terrain database's resolution and level of detail.

Corridor surveys, aviation, communications, area developments, engineering, construction activities, environmental, and cadaster applications all use Digital Surface Models (DSMs) or DEMs to help with pre-planning and layout.

Military operations, flight simulator development, disaster management, building mapping, updating and maintaining cadastral databases, change detection, and virtual reality are just a few of the applications that require 3D visualization models.

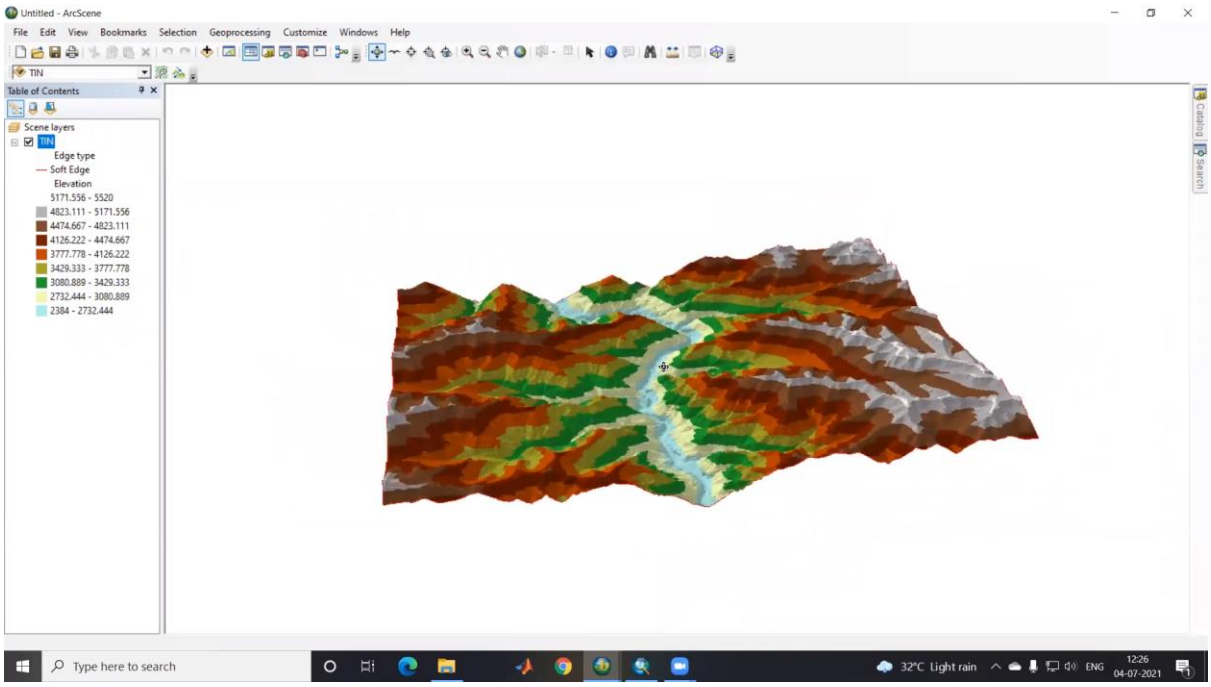

Figure 9 Showing 3D visualization terrain modeling using SRTM DEM data

3D Building Modeling:

New demands for 3D Object Model are arising as a result of new advancements in urban planning, urban landscape, real estate management, and so on. In a 3D object model, the building models are the most crucial. The display component of 3D data capture is frequently studied in detail, but just a few researches into the creation and storage of 3D object models have been discussed (Figure-10).

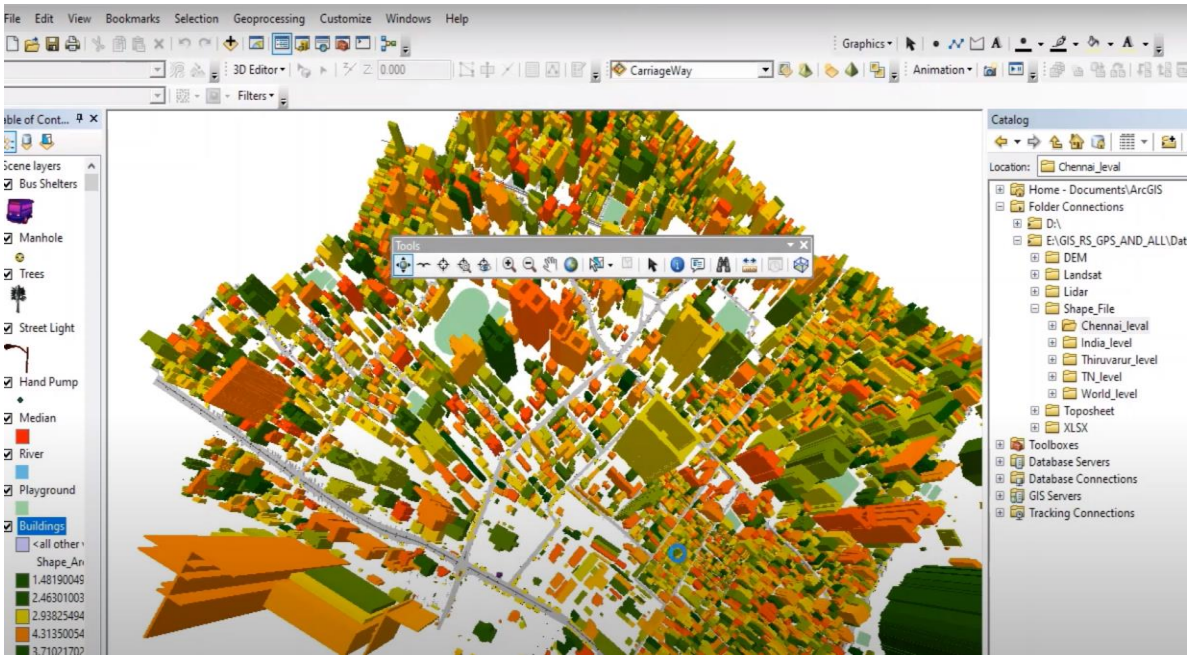

Fig.10 3D Visualization of Building in ArcGIS

3D visualization of flood modeling

Assessment of flood damage and risk assessments are critical components of catastrophe planning and mitigation. Because of a lack of timely (real-time) flood inundation information, planners are unable to deal with emergency management and disaster assistance. While this is going on, the general people are unable to rapidly identify high-risk areas and recognize the possible danger. Consequently, developing an information system to forecast, prepare for, and estimate flood inundation in order to prevent flood disasters is extremely important (Figure-11a & b).

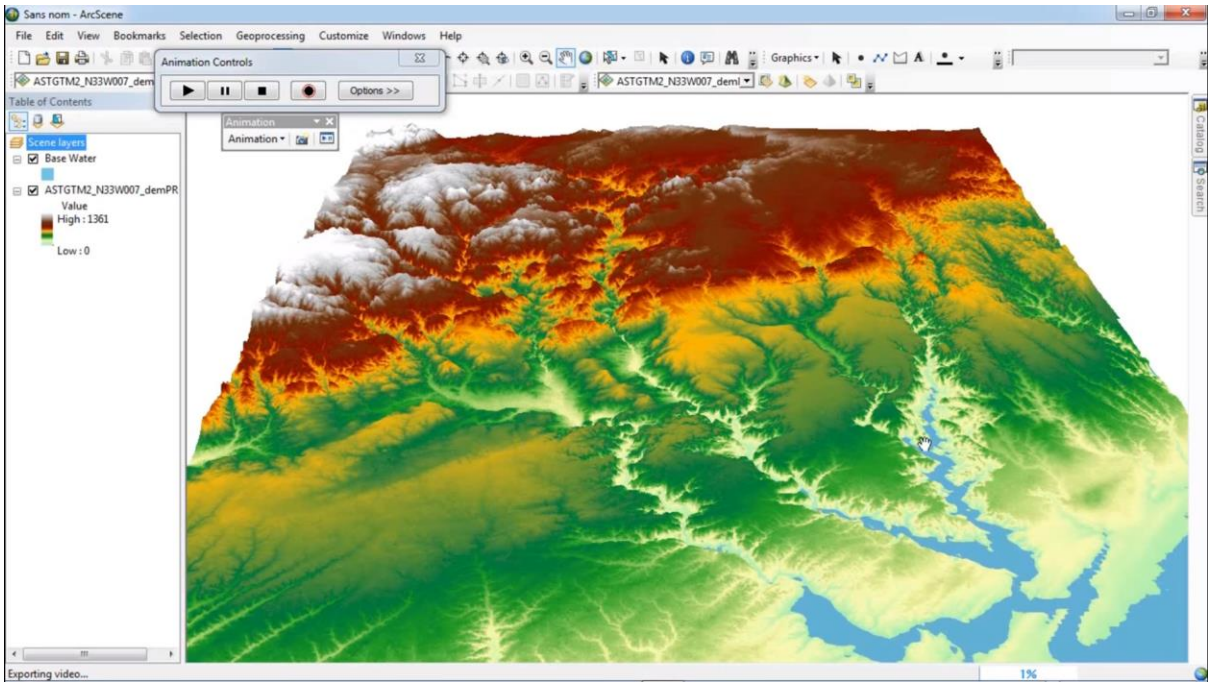

Fig-11a Before Flood modelling image

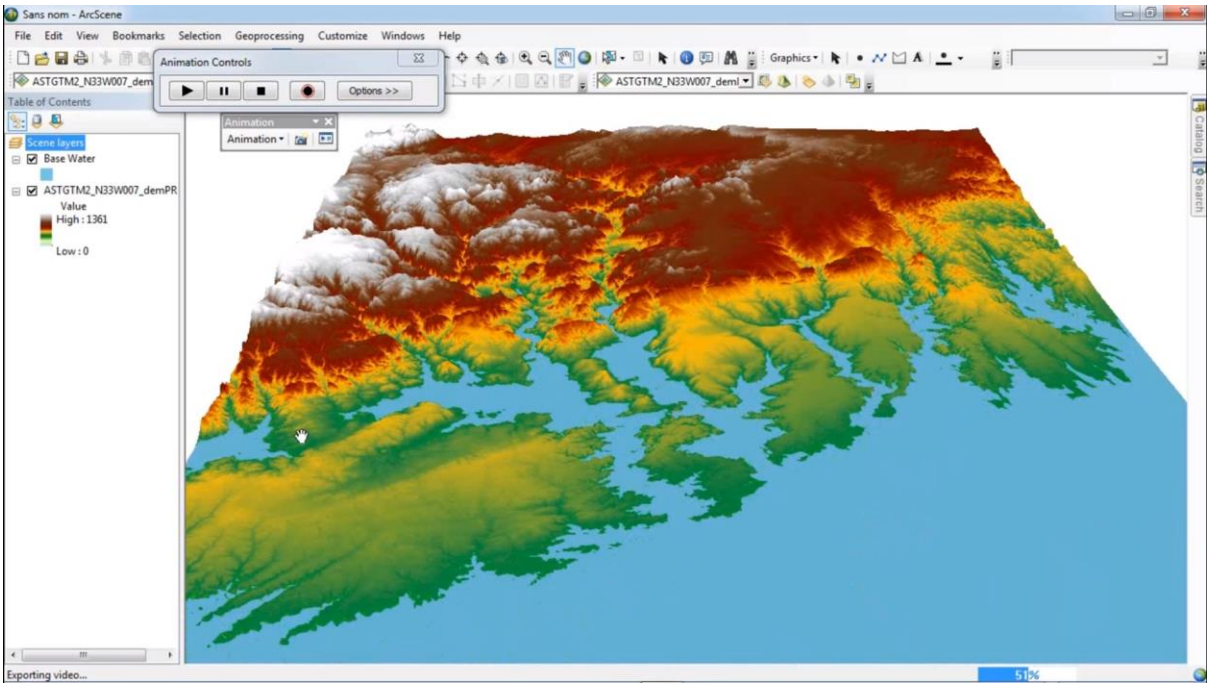

Fig-11b After flood modelling image

In the above figure we can able to see change detection of pre and post flood simulation. Using ArcScene we can have an idea how much area can be affected after the flood takes place in the area.

3D Modelling and photorealistic visualization of Tsunami using geospatial Techniques

The Subduction zones of the Andaman-Sumatra Subduction zone in the east and the Makran Subduction zone (MSZ) in the west Indian Ocean are depicted in three-dimensional (3D) model (Figure-43). The Makran Subduction zone, located in the western Indian Ocean off the coast of Karachi, Pakistan, has a history of generating tsunamis that have impacted the whole region. It was Stoneley (1974) that hypothesized the existence of this Subduction zone between the Arabian Plate and the Eurasian Plate, and it was subsequently Shearman (1977) as well as Farhoudi and Karig (1977) who clarified the mechanism associated with its formation, according to Heiderzadeh et al (2008). One of the largest forearc sections on the planet, it also has an active accretionary wedge that is 70-100 million years old.

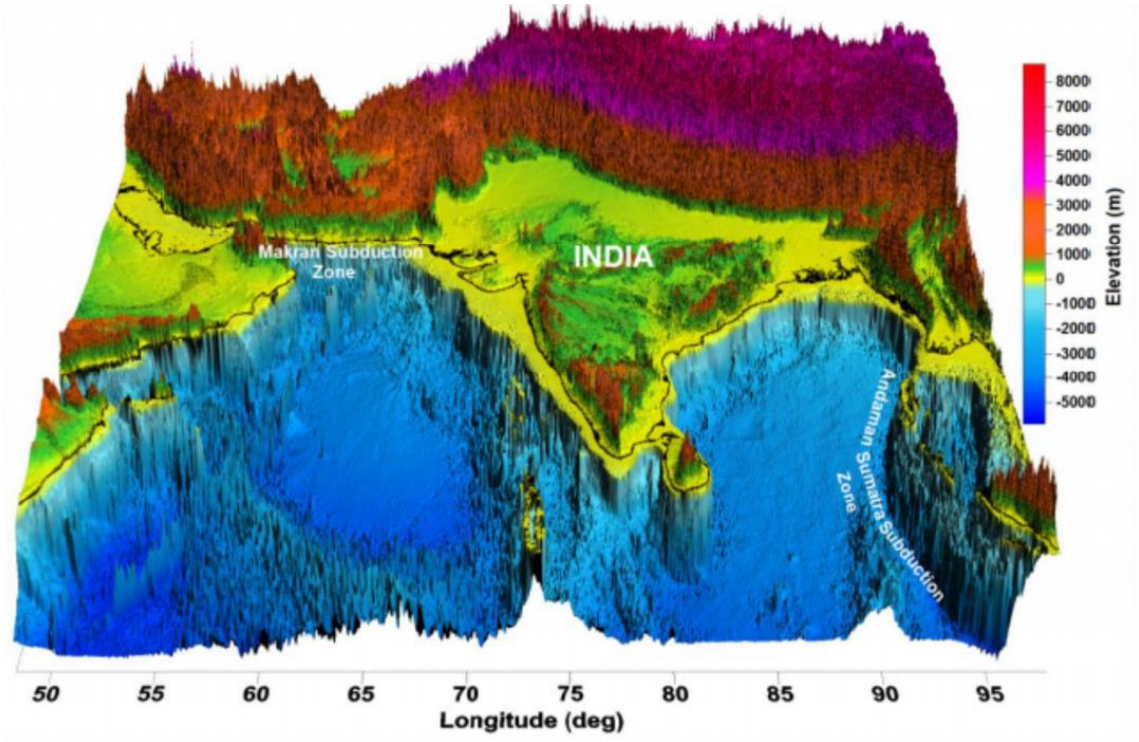

Fig-12 shows 3D Visualization of tsunamigenic sources in the Indian Ocean

An overview of the earthquake's geological location and seismic features, as well as a description of tsunami production modelling for this event and the M=9.3 earthquake that struck northern Sumatra on December 26, 2004, are provided in this paper.

In this earthquake, a massive fault emerged that stretched from northwest Sumatra all the way to the Andaman Islands. Because of the magnitude of the 2004 earthquake, we must include the

time it takes for the fault to unzip along its length in tsunami calculations. When this earthquake occurred, the rupture front moved at a rapid pace of approximately 2.5 km/s, which is typical of Subduction zone earthquakes and is similar to a crack propagating in a frozen lake. In total, the rupture front moved for approximately 8 minutes from the hypocenter to the end of its 1200 km excursion (which was nearly the length of California!). Given that tsunami waves travel at a slower rate than fault rupture, the displacement of the seafloor caused by an earthquake of lesser size is assumed to occur instantly in tsunami models for smaller earthquakes.

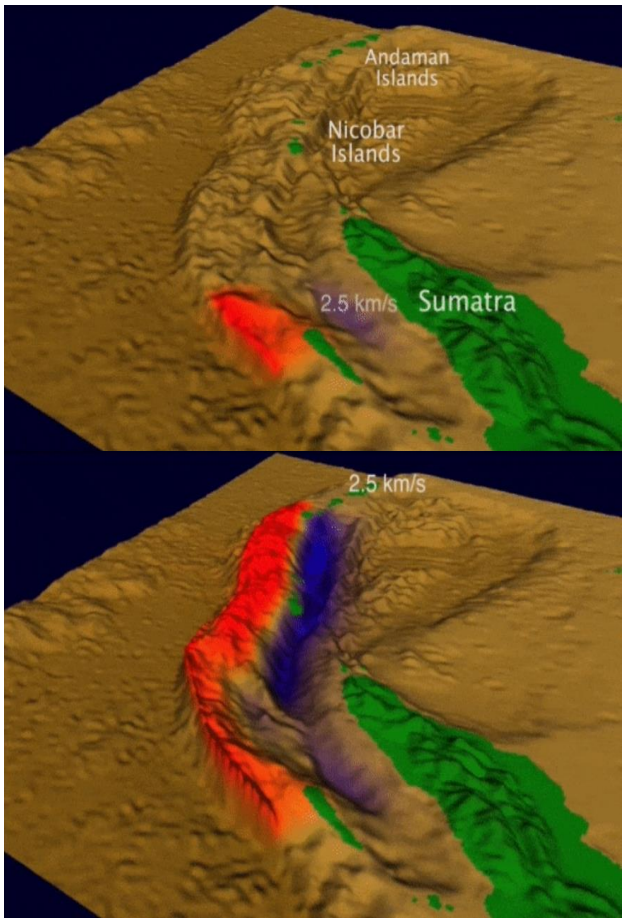

Fig- 13 An illustration of the vertical seafloor displacement caused by the earthquake that struck Sumatra and the Andaman Islands on December 26, 2004 in this 3D graphic. As well as an exaggeration of the seafloor's vertical displacement, the rupture front's northward spread is represented in this illustration. The water has been removed from this 3D image for clarity. Whenever the seabed rises in elevation, it is Color red, and whenever it descends in elevation, it is Colored blue. (Image credit of Tsunami Generation, which was created by the M=9.1 Sumatra-Andaman Earthquake of 2004.)

The addition of water to this 3D model allows us to depict how tsunami waves propagate away from the earthquake's origin. By the time the earthquake rupture reaches the Andaman Islands, the tsunami waves generated at the commencement of the earthquake rupture have already travelled a portion of the distance into the Bay of Bengal, as illustrated in the graphic below.

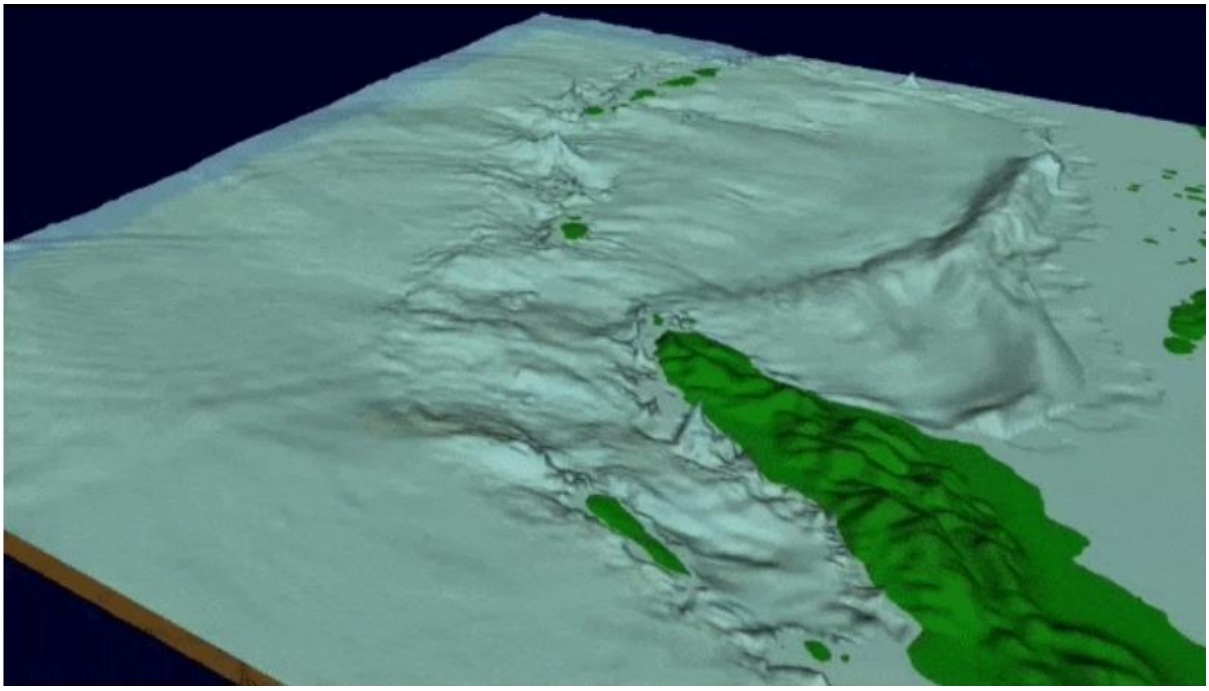

Fig- 14 This 3D picture depicts the evolution of tsunami waves caused by the earthquake that struck Sumatra and the Andaman Islands on December 26, 2004. Given that it takes around 8 minutes for the entire fault to rupture, tsunami waves generated near the epicenter have already made their way halfway into the Bay of Bengal by the time the earthquake begins to generate additional tsunami waves near the Andaman Islands. These waves then make their way over the Andaman Sea to the Thai mainland and coastline. (Photo by Eric Geist, geophysicist at the United States Geological Survey's Pacific Coastal and Marine Science Center)

Conclusion:

The present study shows 3D visualization techniques for slope maps, Aspect maps, and Hillshed maps, as well as their practical implementation in a real-world environment. A 3D elevation map of India is also included in this article, along with elevation information for each site. These maps can be utilized in a variety of applications, including urban planning, geology study, hazard monitoring, natural resource research, and agricultural management. The provision of 3D geographic data is a time-consuming, cost-effective, and labor-intensive process that every mapping project inherits from the Data Collection phase. Aside from this stage, the availability of tools that evolve around real or virtual world data is progressing through software development and the existence of appropriate application-oriented software. This tool should be able to perform both analysis and visualization. Under the terms of Spatial Data, the two subjects indicated above, namely data and application can create an environment for 3D GIS and, as a result, a spatially enabled society.

It is explained in detail how 3D GIS modelling and visualization can be used in a variety of different industries. A major focus of the research is on technological methods to data modelling, cartographic design, and the practical use of the 3D maps that have been produced. Specialized geographic information system (GIS) software is used to create and visualize 3D models. This software enables for the modelling of real-world object features at a granular level of detail. It is demonstrated how to use several visualization approaches to depict 3D Terrain modelling, 3D Building modelling, LULC mapping, and geological mapping, among other things. The applied approach makes it possible to give an appealing depiction of the 3D geovirtual environment as well as realistic renderings of 3D maps in three dimensions.

The 3D models and 3D maps that are created are generated at various degrees of detail and generality depending on the needs of the user. Not only does the mapping process seek to improve understanding of modelling methodologies, but it also seeks to improve understanding of end-user needs. When it comes to cartographic design and applications, this underlines the tremendous degree of personalization available. Further research into the efficient presentation of geospatial information by including additional context within 3D maps is required, as demonstrated by the current work.

A geographical perspective on tsunami dangers is provided by this illustration, which will most likely assist the general public in visualizing and comprehending the threat. This technique is useful since it incorporates certain realistic characteristics while also increasing the level of engagement. It is possible to get anything by seeing this tsunami disaster representation. To assist student's visualize the concept of a tsunami and comprehend how it arises and influences them, 3D visualizations can be utilized in a classroom setting. When individuals understand what a tsunami is, they are more likely to survive one. Once the subject has been explored, they will never suffer simple phobia again since they will understand how it occurs and the repercussions of experiencing it in the first place.

Once people comprehend the concept of a tsunami and its impacts, they will be able to set up a self-alert to this danger. Because they are aware of the devastation that tsunami waves may inflict, they will never choose to dwell in locations where tsunami waves have a high probability of collapsing in. The fact that children are familiar with tsunami characters serves as a reminder to them of the need of eradicating this phenomena by shifting to safer regions; after all, as the phrase goes, "prevention is better than cure." Users can have a better understanding of tsunamis and see how they can prevent themselves from being killed by large waves generated by tsunamis by using 3D Tsunami modelling software.

Organization of Thesis

Chapter 1: Introduction

This Chapter deles with the introduction about the Remote sensing & GIS techniques used in the 3D Visualization of geospatial data, Furthermore, we also explain need for 3D geospatial data modeling & problems associated with the 3D geospatial data modeling.

Chapter 2: Literature Review

In this section, previous research work with diverse theories, methods, models and procedures by different researchers are explained. This would allow analyzing and designing novel conceptual model or framework for research problem.

Chapter 3: Materials, Methodology and Algorithms

The materials which we used for the 3D Visualization mapping, Methodological approach and algorithms which used for in preparation of 3D Model is discuss in this section.

Chapter 4: 3D Algorithms and visualization of DEM data

In this chapter we discus about the 3D modelling of DEM, showing 3D visualizations and algorithms used for Slope map, Aspect Map & Hillshed map also explain about the 3D visualization importance of watershed mapping.

Chapter 5: 3D Visualization of geospatial data

The detail explanation about the 3D modelling visualization of terrain, 3D building modelling, 3D visualization in of Land use and Land cover, 3D visualization of geological mapping & 3D visualization of Flood modeling is explain in this section.

Chapter 6: 3D Modelling and photorealistic visualization of Tsunami using geospatial Techniques

In this Chapter we discuss about 3D Visualization application in Tsunami modeling showing example of Andaman-Sumatra earthquake 26 December 2004, also showing Change detection of pre and post tsunami disaster images.

Chapter 7: Conclusion

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List of Publication

1. Sharma D. & Rudrawar S.(2021), Algorithms for 3D Modelling and Visualization of digital elevation model, International Journal of Research in Engineering and Science, ISSN (print) 2320-9356.
2. Sharma D. & Rudrawar S.(2021), 3D modelling and photorealistic visualization of Tsunami using Geospatial technique, International Journal of creative Research Thoughts, issue 12 December 2021,ISSN 2320-2882